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Science, Technology, Engineering, and Math: Gender Inequity in STEM and 4H

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SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH: GENDER INEQUITY IN STEM AND 4H

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Abstract

As a female STEM Ambassador, a representative who encourages k-12 youth to go into the STEM fields for 4H camps in West Virginia, I observed and analyzed multiple counties in regards to identity, privilege and community. Being a very inclusive program, 4H is a youth development program that teaches leadership and community through hands on experience. Based on field observations, this paper discusses and analyzes with an intersectional framework how gender impacts STEM education and potential ways to improve upon such a foundation with works from both Feminist and Post-Structural Theory.

Introduction

In almost every facet of our society, women and girls are treated in a too often degrading fashion. One way in particular is women historically have been barred, socially, from being encouraged to enter the STEM (Science, Technology, Engineering, and Math) fields which are predominantly male. One study showed that there is a turning point for young girls in middle and high school with their relationship to science and math (Seymour & Hewitt 1997). At this age, they start to lose interest, lack confidence, and want to avoid engaging with the subject entirely. Girls are not encouraged to pursue careers in sciences, because it is not expected of a woman to go into a hard science in our society. Seymour and Hewitt's study focused primarily on undergraduates, but it is important to look at where women learn the ideology of lacking confidence in their abilities in the sciences to begin with.

In response to the paucity of female professionals in the sciences, programs and opportunities have been created to encourage girls -- primarily middle and high school girls -- to pursue careers in the STEM fields. These are often university based programs such as the one at Duke University called FEMMES (Females Excelling More in Math, Engineering, and Science) (Bonhivert et al 2008). This program, in particular, was a one day event that had activities relating to engineering, math, and science that was taught by female faculty. Surveys were conducted before and after the event, assessing the youth's interest, knowledge, and confidence in the aforementioned fields. Their findings concluded that interest in all three areas surveyed increased, most notably engineering. Though this was geared towards girls specifically, it shows the possibility of the program and other programs like it being a confidence builder for youth and their relationship to STEM, giving them a solid foundation with which to launch into college and maybe even a career.

Programs which encourage girls to go into the STEM fields, usually take one of two main approaches to get them involved. The first focuses on the gender stereotypes, using them in a way so as to garner interest (Nerd Girls 2013). In these types of programs, being smart is considered sexy as well as being highly feminine. The site is colored pink, both showing and blatantly stating that being in a STEM field as a woman does not require the loss of femininity. It could be argued the image of girls' femininity and how they are perceived by external sources is more important than the actual material being taught in these types of programs. These programs are making the assumptions that girls love pink, are highly feminine, and that they are, "Developing real world projects using your all your talents, not just your book smart talents, to solve problems in your community or in the environment" (Nerd Girls 2013). These programs not only use gender roles to their advantage but also take advantage of the fact that socialization of peer groups impacts what subject girls are motivated to do well in (Farkas, Brown, and Leaper 2012). With this presentation, girls may or may not be more inclined to join a program relating to the STEM fields like this, depending on that girl's relationship to her peers and her own gender expression.

The other type of program that is used to recruit girls to the STEM fields are ones that are more focused on giving girls the skills they need to succeed at jobs within the STEM fields (Techbridge 2013). In these

programs, girls work on projects such as computer-animations and remotely operated vehicles after school. Girls get hands on experience and build confidence to further their education in the STEM fields by participating in STEM related projects that require them to learn new skills such as working with their peers and adults and working with technology they might not otherwise have had the opportunity to do. Gender is less a factor in these types of programs, because the only factor for them is that it is tailored to girls only.

Even though these programs, at first, seem very beneficial, it is important to keep in mind that their goals may not have been reached and they are not as effective as hoped for (Salmon-Stephens, Peters, and Landgraf 2008). Salmon-Stephens, Peters, and Landgraf looked at the preliminary results of some of the outreach programs within the University of Wisconsin. They found that the effectiveness of these programs is reduced over time. Young girls in this program did not maintain interest in the sciences until they choose a college, because the programs Salmon-Stephens et al. looked at did not target specific ages and were not funded in a manner that made them very consistent. Also, data for the study were only looked at for the older girls who went to their own college.

Another component to consider is that there are other variables when looking at an adolescent girl's interest level in a STEM field such as the social relationships with their parents and peers as well as personal factors (Brown, Farkas, and Leaper 2011). Measuring the academic motivation and how it is impacted by both the relationships with their parents and peers proved that peer support was the biggest factor for girls' in Math/Science or English but never all three subjects. To pique the girls' interest in Math/Science, it was speculated and briefly discussed by Brown et al. that if parents encouraged their daughters to join a STEM-related extracurricular program, then their interest in the STEM fields may rise. Therefore, the style of socialization each of these girls' had impacted them on how they interfaced with gender-typed school subjects. Within part of that socialization, there may be girls who have been taught either directly or indirectly by their parents or peers to believe that they were not capable of being a part of a STEM field. These educational outreach programs which encourage youth, in general, and sometimes specifically girls to gain a better understanding and empowered level of confidence in STEM oriented curriculum can help shift the current attitudes of women in science. By

working for such a program, there is the opportunity to re-gender the way middle and high school girls view their relationship to the STEM fields by showing them the social deconstruction of women being in such fields.

One such program is the STEM Ambassador program of which I am a member. Within this paper, I will discuss my involvement in this program. I undertook this research by taking field observations on gender and its relationship to the sciences across different county camps within 4H. Looking at only the immediate effects of the program after camps and the attitude and perceptions that girl's had with science before and after participation; ways to further increase their interest will be discussed.

Methods

The STEM Ambassador Program

The STEM Ambassador program is specific to West Virginia University (WVU) that works with youth involved in the 4H program's summer camps to recruit youth into working towards or even gaining a career in a STEM field at WVU. Not only does it encourage enrollment at WVU but also general interest in the sciences. The program is made possible through the WVU Extension Service which is a service dedicated to taking the academia of the university and utilizing it in other public communities. A primary community outreach program of Extension is 4H and is made possible through land grant universities like WVU. The STEM Ambassador program is through Extension but interacts primarily with the 4H Summer camps.

Being a STEM Ambassador means travelling across the state of West Virginia to different counties that have 4H camps, teaching STEM oriented curriculum to youth aged 9 to 21. The 4H program is a national youth development program that fosters hands on experience for k-12 youth, proving to be extremely good at skill building and confidence for youth. In West Virginia, 4H is broken down by county, and each county has a 4H agent who oversees everything at camp. Within each 4H camp, the youth are divided into groups known as tribes. They are named after Native American tribes or cultures such as the Cherokees and Senecas.

Camp Structure and Role

Each ambassador in the program has four or five camps that they work over the course for a summer. Most are county camps, but some camps are state camps where youth all over the state can come and participate. Each camp only last a week, and they typically start on Monday and last until Friday. Though, some counties have their staff arrive on a Sunday to make their arrangements and get settled in for the week.

The role of a STEM Ambassador at these camps is to be both a teacher and a counselor. They are a teacher when teaching their class and a camp/cabin counselor the rest of the time. As a camp counselor, they help supervise the youth and prepare for camp activities, meals, etc. STEM Ambassadors also serve as a cabin counselor, making sure that all of the youth are in their appropriate cabin and accounted for before bed time and that general rules and guidelines are followed by everyone. Cabins were assigned by age and gender as the following: younger boys, younger girls, middle boys, middle girls, high school/college boys, and high school/college girls.

A day at a camp normally began at 7 AM in the morning and ended around roughly 10 PM. STEM classes were either taught in the morning or the afternoon, depending on how the camp schedule was laid out. Either way, throughout teaching and being a counselor, there was plenty of time during the day to have to one's self. It was during these times, mainly before bed time, when field observations could be written down and events were recounted to share, specifically in regards to gender and its relationship to the STEM fields observed in the youth at that camp and their attitudes towards it as well as their opinion and attitudes towards me.

Observations and Relationships

In addition to the aforementioned variables, the STEM Ambassador was a stranger to these youth. Both the campers and counselors had never met this person before. Often times, they did not know the local area. The ambassadors were also unaware of the dynamics in the existing relationships among campers, counselors, and parents with one exception – the researcher did serve as a counselor and STEM teacher at

the day camp for her own county of residence. Often times, STEM ambassadors were constantly asking for help on finding cabins, stores, and understanding the nicknames of everything at the rest of the counties.

Being such a foreigner in the county, though, allowed for minimal bias in how the youth treated the ambassadors and how they were perceived by them as well as how they interfaced with them. The newness of relationships with the youth made it easier to communicate with the youth at these various camps, because they had no prior relationship with or opinion of the ambassadors. Knowing this, it was easy to make observations because of the ease with which one could be objective. Recounting each day's events at camp that stood out to the STEM Ambassador or related back to girls and their relationship to STEM was done each night before bed or immediately after the event happened. The observations were then broken down by age group and type of interaction throughout all five camps (see table 1).

Table 1 Breakdown of Age Groups for Youth at Camp, By Age Group and Ages

Age Group	**Age**
Elementary School	8-9 years
Middle School	10-13 years
High School	13-18 years
College	19+ years

Camp Order	**County Name**
1	Hampshire
2	Ritchie
3	Marion
4	Fayette
5	Monongalia

STEM Curriculum and Class

The STEM oriented curriculum that was used in classes was taught for one week at a training camp to the ambassadors where they learned how to adapt and modify their lesson plans based on how each camp was set up which varied from county to county. There were eight different curriculums available for the STEM ambassadors to teach from. They were the following: Bridge Building, Legos, Forensic Science,

Agriculture, Chemistry, Solar Cars, Geocaching, and Circuitry. Youth at the camps were most excited about Forensic Science, Solar Cars, and Geocaching, because those had the youth involved in activities that they had either not been exposed to or had a personal interest in. A significant portion of youth at each camp had participated in the same program the year before and had talked about it excitedly, since this was the program's second year.

Resource kits for each subject were given to the ambassadors at training camp; they were to bring their supplies to camps with them. Materials included things like Legos, powder for dusting fingerprints, crime scene tape, and soap and buckets for bubbles to name just a few. It was also understood that the time given to teach varied from each camp and that which curriculum was taught was either at our own discretion or requested by the agent of the county. Some of the curriculum was so adaptable that a couple of times a theme at one of the camps was an opportunity to incorporate the material that the STEM Ambassador was expected to teach.

Typically, a STEM Ambassador teaches two to three classes a day to the same group of campers ranging in size from 7-22. Most of the youth ranged in education from elementary school all the way to college. They were often taught without any extra adult supervision or assistance except for when another counselor was checking in on what the class was doing, or it was a camp wide activity. Teaching time was anywhere from thirty to fifty minutes per class, but this also varied from camp to camp. However, at most camps, there were activities that were camp-wide activities, meaning one person was in charge of an assembly or an event for the entire camp to do with the help of the rest of the counselors. A STEM Ambassador almost always had at least one of these activities to do per camp.

Results

In observing the youth at these five counties, there were two very common trends with the girls across all camp. The first is that nearly all of the girls in both middle and high school had low interest in the sciences, and the second is that after participation in the program, those same girls appeared to feel more confident in their ability to do activities relating to the STEM curriculum. Not only did a shift in

attitude occur with the girls, but there was also a shift in perception among the boys as well about who could participate in STEM based activities.

Girls' Relationship with Science

At the beginning of the week, the girls were shy or insecure or scared to ask questions or even claim any label considered "nerdy" The youth not knowing the STEM Ambassador, were very inquisitive about the ambassador's current occupation, my school, and where she was from, though, so the topic of gender and STEM fields came up frequently. In one incident I observed the following which was marked as an Uncomfortable interaction and will be referred to as Example 1:

> A girl asked me what I was writing down just now, and I told her it was for one of my classes. She said to me, "No offense, but that's nerdy." I asked if she knew the previous STEM Ambassador, because he worked this camp last year. She said no. I asked what classes she was in. Mine is one of them (Weird Science). She said, "Don't ask me to do anything nerdy, because I'll suck at it." One of the male counselors, an elderly gentleman, said, "No you don't. You're in my club, and that's nerdy!" The girl denied this and retaliated by messing up his hair as he walked by her top bunk.

By the end of the week, they were much more open minded and forward in regards to asking questions about the material and about their skill level with that material. Some of them wanted to be walked through certain activities. Others kept asking how much were materials and where could their parents buy the materials for a solar car. Many of the kids in the classes would request one specific activity that they had heard about from last year or had heard was available.

Even though classes were comprised primarily boys who wanted to play with Legos or build robots, the girls that were in the class told their friends, counselors, and even parents when they came to pick their child up. This was observed as multiple youth brought their parents to the STEM Ambassador to introduce them as their friend and express the lessons that had been taught to them throughout the week as well as to counselors during other activities and when exchanging pleasantries in their cabin with friends. Many girls who were not in the class and had

queried me about what was done that day in class were jealous or disappointed that they were not going to have the opportunity to build a burglar alarm or go geocaching. Some of them wanted to spend their free time doing such activities, but most of them thought they could not or should not or that it was "gross" to be a part of something so "nerdy" However, there were a couple of moments where girls were positive in expressing their enjoyment of the sciences, but there were other girls who responded negatively to their peer being interested in a subject they lacked confidence in or disliked. One such example was marked as a Friendly interaction and will be referred to as Example 2:

> A girl just asked me if I was good at math, and I told her somewhat. She said she loved math, and it is her favorite subject. She's going into 5th grade. She's a Cherokee, and she told me her great-grandmother was one too. We tried to figure out what fraction of Cherokee she'd be then, and a girl came by and said, "I hate fractions and division and big numbers. I like 0 x 0!"

The girls that were in those classes, however, worked much harder than the boys did in completing their assigned tasks. There was one class where Robotics was taught for thirty minutes, and there were two boys and one girl all high school aged in the class. Their assigned task was to have the robot run through an obstacle course that had been made using masking tape. The first boy believed he was above doing the work for the class and so did nothing. The second boy attempted to work with the girl in completing the task but eventually grew frustrated and gave up. Yet, the girl stayed for not only the length of the class but also for both her snack time and free time just to prove that she could do it which she did. This is not representative of all the girls in that were in my classes, however.

Not only were these changes observed in the girls' attitudes about science and their ability to do it, but the STEM Ambassador did not fit their typical idea of what a woman my age (20) should act or look like. I was and am not a feminine woman, and this really confused the majority of the girls that I interacted with. There was one such incident at the pool which was marked as a Traditional interaction and will be referred to as Example 3:

> The entire camp went to North Bend State Park to go swimming for the afternoon. I wore swimtrunks and a tank top to the pool. As we were leaving one girl from my cabin who could not have been older than 13 said to me, "Why are you wearing trunks?" I told her they were more comfortable and liked them better than a bikini. She told me I should be wearing a bikini instead of swim trunks, because swim trunks were for boys.

One girl was shocked I did not do my nails or even really know how to. On top of being in a STEM field as a woman, I was continuing to exhibit a non-stereotypical style of femininity and not conform to the gender roles that had been set up by our society through my dress and general expression which further perplexed the girls that I interacted with. At first, they were mean and degrading about this. Yet, as the week progressed, they grew more familiar and comfortable with the presentation I gave, and some even began to ask why I behaved or dressed in a certain way.

Boys' Relationship with Science

It was not just the girls, though, that were surprised by my actions. The boys in my class could not believe that I was a gamer who had an Xbox Live account and enjoyed Call of Duty which is a very popular video game. Once I let them know I gamed, they shifted their viewpoint of me completely, and I was no longer in a teacher/motherly role but instead in a cool, friendly role. Engaging with their teacher on that level allowed for a much more informal discussion and a sharing of interests and ideas.

Along with this, the boys were also surprised that I was the robotics teacher, because they expected the robotics teacher to be a male, so I was not just questioning the girls' mentality of who could do STEM based curriculum but also the boys'. By the end of their week, they had all asked me to add them on Xbox Live, so we could play a match of Call of Duty, a first person shooter game, and had given me a long list of Skyrim, a role playing video game, quests to complete.

Inference from My Observations

The majority of my observations were done outside of my class, because those were times when youth were more comfortable sharing their thoughts. This is reflected in my observations, seeing as there was only four times the Class interaction occurred, showing that the most interaction I had with people on gender was outside of the class. These outside of class interactions were categorized as Traditional, Uncomfortable, and Friendly with Friendly and Traditional being the two highest (see table 2).

Table 2 Definition and Categorization of Field Observations, By Type of Interactions and Definitions of Interactions

Interactions	Definitions
Friendly	Informal/Casual interactions outside of the STEM class
Traditional	Implied/Perceived gender roles about girls
Uncomfortable	Youth appearing to feel insecure or unsure of topics (both gender and science)

Having made observations throughout all of camp, the interaction that I labeled as Traditional reappeared more than five times as much as the Uncomfortable interaction which shows that youth at these camps were comfortable with the stereotypical gender roles that they were being exposed to and dealing with (see table 3 and Appendix).

As can be seen in the Appendix, the types of interactions that were present among adults was primarily Traditional whereas with the youth had a multitude of type of interactions, though, their majority type were also Traditional. Traditional was the primary interaction throughout all camps, and Class interaction was the smallest. Majority of the comments or conversations that dealt with gender and identity and their relationship to STEM fields occurred outside of the classroom which means there were more opportunities to discuss such topics with the youth during these times than during actual time to teach.

Table 3 Total Number of Out of Class Observations Observed, By Type of Interaction and Total Observations

Interaction	Total
Friendly	10
Traditional	15
Uncomfortable	3

The adults also did not have issue with stereotypical gender roles that were expressed by other adults as well as youth, and this may be because they were either unaware of what they said meant or firmly believed in what they said. Having counselors at these camps are role models for these youth, and having counselors who are not very aware of the gender disparities, it becomes much more challenging to encourage youth to go into a field where the adults are not encouraging them either. This was not the case for every camp I attended. There were only pockets of this in the staff, and I am unsure of how much they interfaced with the youth at camp.

Conclusion

Reviewing the field observations once all of the camps were completed showed that most of the girls at these 4H camps doubted their ability to be involved in anything relating to the STEM fields but were still open to the idea of doing STEM based activities. The girls, though, required much more encouragement than the boys. Some girls were too scared to engage in STEM based activities and hid behind stereotypical gender roles, stating that they could not or were not allowed to participate in those things. This is not surprising, since many of the Traditional interactions I observed had some aspect of or referenced girls being unable to be involved in male-gendered activities. Multiple middle school aged girls at all of the camps I worked told me that Legos were for boys and that they were not allowed to play with them. This meant that aside from initial exposure, these girls also had to be encouraged and told that they could do it, because they already had ingrained in their minds that they could not. Unfortunately, the long term result of this exposure and encouragement has not yet been evaluated. If questionnaires were gathered every year from each camp, then maybe further analysis and inference on what they mean could be done to see if the same kids are staying involved each summer and if exposure and encouragement has any lasting effects.

Since most of the time a child's parent was not a counselor at camp and the youth were not at home, peer support and perceived peer support were obvious factors in letting girls be involved in STEM based activities. If one of the girls wanted to be involved in the STEM activity, they had to try and convince one or more of their friends to do it with

them. They were too uncomfortable in doing it on their own. Often times, they came as a group rather than independently, and this shows how socialization can be excluding girls from the STEM fields. Perhaps if youth could have been given a survey, asking them why they chose the class that they did and to supply at least one or two reasons why, then maybe a better understanding of to what extent socialization is a factor could be seen.

Not only was exposure and verbal encouragement as well as peers crucial in getting these young girls involved in STEM activities, but it was also giving them the opportunity to do it by themselves with little to no guidance or help from an adult. Once they were successful in building a robot or a solar car or a light switch on a breadboard, it fed the notion that they could do it again and do something bigger or better or brand new. It fostered a foundation of encouragement and confidence that is likely lacking or nonexistent in other areas of that girl's life. This program tried to teach youth a skill through hands on experience rather than tell them in an abstract format that requires them to go out on their own and learn it. In this aspect, the STEM Ambassador program did a good job achieving that.

Overall, this program is one that uses appropriate curriculum to engage with k-12 youth, and even though it does not target girls specifically, it has great opportunity for transforming the perceptions about girls' working in the STEM fields, dependent somewhat on the STEM Ambassador. Their position allows a lot of flexibility in terms of how curriculum is taught which can open up countless possibilities for altering the way in which youth see gender identity and expression in relation to their careers. With this, being enrolled in such outreach programs can improve a girl's confidence and encourage her to pursue a field she might not otherwise have pursued because of our societal constructs around women having a career in the STEM fields.

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Appendix

Camp	Age Group	Type of interaction
1	Adult	Friendly
1	Adult	Friendly
4	Adult	Friendly
2	Adult	Traditional
2	Adult	Traditional
4	Adult	Traditional
3	All Ages	Friendly
3	All Ages	Friendly
4	High	Friendly
4	High	Friendly
3	High	Traditional
3	High	Traditional
4	High	Traditional
4	High	Traditional
4	High	Traditional
4	High	Traditional
4	High	Traditional
1	Middle	Friendly
2	Middle	Friendly
2	Middle	Friendly
2	Middle	Class
2	Middle	Class
4	Middle	Class
4	Middle	Class
1	Middle	Uncomfortable
1	Middle	Uncomfortable
2	Middle	Uncomfortable
1	Middle	Traditional
2	Middle	Traditional
2	Middle	Traditional
2	Middle	Traditional
2	Middle	Traditional